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AND
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(OF THE SCIENTIFIC STAFF IN LONDON OF THE
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REPORT IN CONNECTION WITH VISIT TO THE EAST

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* Papers presented at the Fourth Agricultural Conference, Peradeniya, October, 1930.

REPLANTING AND REJUVENATION OF OLD RUBBER*

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UNTIL very recently a crop of 500 lb. of rubber per acre was looked on as very satisfactory even in the best rubber districts of Ceylon where probably the highest average yields obtained in the East are still registered. The fact that even the first fruits of experiments in the raising of high-yielding strains have shown that this yield can with practical certainty be doubled if not trebled clearly proves that the rubber plantation industry was started in a hurry with no thought to the quality of the material employed. Seeds were bought by the thousand because they were Para rubber seeds and the result is that we have large areas of mediocre trees. There is little to wonder at when we see signs of uneasiness among owners and hear questions raised about the possibility of replacing their poor trees with more productive varieties.

With the present depression in the industry efforts have had to be made to reduce the costs of production to a minimum and in many cases estates are still working at a considerable loss. Whether the present prices for rubber are likely to improve to any very great extent I am unable to say but it is unlikely that they will ever reach the phenomenal heights that they have attained on occasions in the past. The only way in which costs of production can, in most cases, be reduced still further is by obtaining an enhanced yield. This is practically impossible, economically, on older estates which are yielding 300 to 400 lb. per acre and it is not difficult to forecast that such properties will be unable to keep their heads above water when the area under budded and selected rubber is increased so that it amounts to a significant proportion of the world's total.

It would appear that the higher-yielding estates, by dint of extra manuring and special effort to increase their yields to a maximum, will be able to carry on at a profit for some considerable time but that neglect of agricultural works in time of depression may eventually put them in much the same category as the poorer estates. The latter in my opinion will be forced to replant or abandon, if not now, at least within measurable time.

* Read by T. E. H. O'Brien, M.Sc., A.I.C., Chemist, Rubber Research Scheme (Ceylon).

Such properties would, I think, be well advised to experiment with replanting. There is no need to undertake extensive schemes at the outset, as in all probability still better planting material than at present available will be on the market shortly, but it seems wise to make a start now before reserve funds are still further depleted by trying to bolster up out-of-date properties.

In view of the present excess of supply over demand the question as to what is to be done with this extra rubber is only natural. I am not competent to deal with this but it would appear that many new outlets would be exploited if producers could supply rubber profitably at a low figure. Roadmaking is a case in point. I feel sure that the difficulties attending the laying of rubber roadways would soon be surmounted if rubber could be obtained for a number of years at a price at which it could compete with other materials. This argument merely supports the statement that many estates will have to increase their production or close down. Dividends will be the perquisite of properties which can reduce their costs of production so that they can sell at a profit at prices approaching the present selling price of the commodity.

THE TERMS "REJUVENATION" AND "REPLANTING"

Attempts to improve the productivity of old rubber areas may be made in two ways. Either the land may be completely cleared and replanted, or a percentage of the best trees may be left and the vacancies created by the removal of the poor trees supplied with young high-yielding stock. The former is generally termed replanting and the latter rejuvenation.

REJUVENATION

Rejuvenation it is thought will be applicable only in special cases. The retention of even a small percentage of the best trees introduces an element of competition for light and ground space and the young supplies consequently suffer. As however the system is attractive in respect of the fact that the land is never completely out of production, a few comments may not be amiss.

Young rubber raised from proved budded stock has yielded as much as 10 lb. a tree in its first year of tapping and there is no reason to suspect that this yield will not be augmented as years go on and the trees increase in size. For this reason it will be uneconomical to leave permanently any tree yielding less than this amount. This is the lowest limit which should be considered and it will be preferable to leave no tree which does not reach "mother tree standard" that is, which does not yield at least five times the average yield of the trees in the field.

Considerations of shading must also be taken into account and not more than 10% of the previous stand should be allowed to remain. It is thought that if this maximum is exceeded disappointment will result. A greater stand will interfere with planting operations, with subsequent cultivation in the early years, and with the growth of the young plants.

It may be possible or desirable in some cases temporarily to leave the best 25% of the old trees to help to cover the costs of replanting. Such a stand can be expected to give 50 to 60% of the previous yield at a cheaper rate of tapping, but it is estimated that two years will be the maximum length of time that this will prove satisfactory. The danger of damage to the young plants during the subsequent felling increases greatly after this. In such a scheme I consider it advisable to plant up the full stand of young rubber as far as possible at the beginning so as to avoid the necessity of extensive supplying when the old trees are removed.

REPLANTING

The concluding part of the last section really belongs to this as none of the original trees are eventually left. Wherever possible a clean sweep at once or at a very early date is considered preferable. The young areas are given every chance to put on uniform growth. An uninterrupted contour system can be laid down and generally the work is simplified. The retention of known mother trees is naturally desirable no matter whether a clean sweep is being made or not. These are usually so few in number that they will interfere with none of the operations.

OVERTAPPING PRIOR TO REMOVAL

The desirability of realising as much as possible of the capital invested in the old trees need not be stressed. Some form of heavy tapping should be employed but reliable data on suitable methods are scanty. One thing which recent experiment has shown, however, is that, if it is desired to keep up such tapping for a year, or two, the system must not be too drastic. Tapping to the wood is undesirable except probably during the three months immediately preceding removal.

The following scheme has been tentatively suggested in an article in the April number of *The Tropical Agriculturist*, 1930:

Open the normal cut on each side of the tree and tap both on alternate days to the normal depth and with normal standard of tapping. Such tapping should avoid the bottom 9 inches or foot of the panel so that this may be available for use the year before removal. Tapping of this description can probably be kept up several years if bark is available.

The year before removal both cuts should be put down to the base of the tree so that the lower end in each case is about 9 inches above ground level. Tapping here is continued in the same way except that during the final three months tapping may be carried out to the wood and subsidiary cuts put in wherever bark exists which can be profitably exploited.

It is thought that the yield from the earlier year or years of heavy tapping may raise the normal production by 50% and the final year by 100 to 150%. These figures are merely estimates in the *real* sense of the word.

Where rejuvenation is favoured the trees to be retained will naturally be tapped in the normal way, one half cut on alternate days, and in the early stages the same will hold good where a larger percentage is being left as a temporary means of revenue. Overtapping of these latter will later follow the same lines as suggested for the generality.

Tables have been prepared showing estimates of expectation of crop during the period of replanting, including heavy tapping, and the earlier years of production of the young budgrafts. These can be inspected.

TAPPERS' TASKS DURING OVERTAPPING

The size of tappers' tasks will have to be reduced during overtapping and, to what extent, will have to be decided by trial and by a study of the economics of the situation. There are two factors here which are antagonistic: (a) if small tasks are given, say 110 trees, costs of tapping will probably be much as before; (b) with larger tasks, say 150 trees or more, the costs of tapping can be made lower but the yield will be less owing to the later tapping of a large number of the trees. In the present state of the market it is possible that smaller yields at a lower cost will be more profitable.

REMOVAL OF TREES

There is no reason why, during the period of heavy tapping, any completely useless trees should not be removed. If required for firewood the timber can be kept fresh by cutting the roots on one side, pushing the tree over and leaving one of the large roots unsevered. The severed roots can be removed gradually. The extra space may benfit the remaining trees and at least the extra light will help in the establishment of a heavier ground cover. When the final clearing is undertaken the trees will have to be removed fairly completely, root and all. It is unnecessary to finecomb the ground for rootlets unless *Fomes* is known to be present but at least all large roots must be taken up. The cost of this work will vary with circumstances but it is thought that an average of Re. 1-50 a tree should be about the maximum spent.

It has been said that to do the job thoroughly would cost about Rs. 4-50 a tree, but is it likely that the extra Rs. 3-00 spent as a safeguard against the possibility of root disease in the future will be economic ? This amounts to Rs. 300-00 per acre and *Fomes* or other outbreak will have to assume unheard-of proportions to necessitate the spending of this amount per acre on eradication during the ensuing decade.

Regarding the method of removal there are no doubt many present who are better informed than I am but it is probable that elephants or monkey grubbers will prove economic. The final removal of roots will in either case have to be done by coolies.

DISPOSAL OF TIMBER

It may be possible in certain circumstances to sell a proportion of the timber as firewood and, in fact, the possibility in specially favoured cases of selling the trees to a firewood contractor before they are felled should not be overlooked.

It has been suggested that the timber could be converted into charcoal and stored in that form as fuel for suction gas engines.

Apart from the above there is little to suggest but burning. When recourse is had to burning, however, it should be localised so as not to deplete the soil still further of organic matter. Burning over previously cut trenches or holes is recommended.

The possibility of converting wood into synthetic farmyard manure has been suggested but as no information is available as to the feasibility of this method of disposal no suggestions can be made. Furthermore the cost is likely to be high.

RENOVATION OF OLD SOILS

The question has many times been asked whether these old washed-out soils can support a further crop. In their present state I do not think so, at least satisfactorily, but there is no reason why, with care, they should not be brought back to a satisfactory condition of fertility. It is common knowledge that our Ceylon soils and probably all tropical plantation soils lack nitrogen and, even more so, organic matter. In the past many estates, as well as neglecting selection of the material to be planted, made no effort to employ careful planting methods. Stumps were put in with alavangoes and no precautions were taken to retain the original fertility of the soil. The resulting trees are smaller than they might have been and yields are lower in consequence.

Nitrogen, phosphates and potash, the active constituents of manure mixtures, can be supplied to the soil fairly cheaply nowadays but it is expensive to purchase all the organic matter

required from the manure merchant. When the old rubber is removed every possible source of potential humus must be exploited. Trees felled just after they have put on their new head of foliage will supply two lots of leaf, one on the ground and the other which can be removed from the felled trees while it is still green and in a form in which it can readily be incorporated in the soil. Large quantities of plant material should not however be dug in alone unless it is known to be fairly rich in nitrogen content. A nitrogenous manure such as calcium cyanamide or mixtures containing cyanamide should be added at the same time. The soil organisms which are responsible for the breaking down of this material make use of quantities of nitrogen-containing compounds and if this amount is not added with the green matter it must be supplied by the soil. The quantity of nitrogen thus abstracted is locked up in the bodies of these organisms during their life and is not available for plant food, and this may even suggest in some cases that the addition of green matter is detrimental. Only on their death is the store released. It is however not desirable that the numbers of these beneficial bacteria should be allowed to decrease; an increase should be aimed at, since without their presence soils become poor. They are found in their greatest number in soils which are said to be in good tilth.

In jungle the soil fauna, and flora are extensive and humus is plentiful. One finds earthworms and other creatures which are almost completely absent from estate soils. Humus consists very largely of broken down plant roots and other plant debris which has been carried underground by the agency of such animals as earthworms. Unfortunately a very large proportion of these beneficial organisms are destroyed when a clearing is fired and their increase should be studied later by bringing about the right conditions for their existence. Soils which are plentifully supplied with the right organisms require little cultivation, they open up the soil in a more efficient manner than the average forking. Aeration is permitted and, as plant roots breathe as well as the above ground portions, growth of plants is encouraged. For their continued existence and multiplication a sufficiency of plant residues is essential and this is most economically provided by growing, pruning, and burying large masses of green manure on the land.

The terms green manure and cover crop are frequently considered synonymous. I prefer to apply cover crops to the creeping plants whose main function is to keep the soil in position, although in most cases they also have considerable green manurial value. These will be dealt with in the next section. By green manures are meant the tall growing plants which by their nature can stand several prunings per year and survive to

produce a large bulk of material for burying. Among these are the Tephrosias, Crotalarias, some Desmodiums, Sesbanias, Indigoferas, etc., and it is to my mind desirable on replanted land to have the areas between contours full of these so that they resemble miniature forests. Only in this way will it be possible to obtain the necessary weight of organic matter to bring back the soil to a reasonable fertility.

While it is desirable to have the top foot of soil all over the plantation in a good state of tilth with sufficient humus I would advise, in the case of replanting, the localisation of burying of such material. The rubber is the main crop and burying in pits near the young plants is preferable to distributing the available material all over where most of it will be out of reach of the limited root system. When the trees get older burying will take place further away and gradually all the intervening ground may be brought to a satisfactory state.

There is one way apart from soil considerations in which this burying of green material may benefit crops. As is well known the factors which govern the growth of plants are as follows: sufficient light, sufficient heat, sufficient moisture, and a soil sufficiently rich in nitrogen, phosphates, etc. Another factor is of great importance and that is the amount of carbon dioxide in the air. All the carbon contained in the plants has been taken from the air by the leaves in the form of this gas. It is elaborated by the leaves to form starch, sugars, etc., which in turn are the raw materials with which the plant builds up new tissue, renews bark, replaces latex withdrawn, etc. Rubber itself contains little nitrogen, phosphates or potash; these manurial constituents act largely as tonics to the tree facilitating the building up of carbon containing compounds. Among the factors mentioned above, light, heat and moisture are usually present in excess in the tropics and the nutrient salts of the soil of well-kept estates are sufficient. The limit to further growth is in all probability drawn by the amount of carbon dioxide in the air. Recent experiments in England have shown that an increase in carbon dioxide in the air results in increased growth in the plants studied. There seems little reason why a different result should be experienced with rubber. The decay of organic material in the soil is productive of much carbon dioxide. Actually in the soil this gas may have an effect similar to yeast in breadmaking, puffing it out to a certain extent and making it friable. Much of it however escapes to the air and is available for further use. The more material buried, therefore, the more gas liberated and the reason for the luxuriant growth in jungles could probably be found in the same factor.

The burying of green manures has been dealt with at some length as I am firmly convinced that only by extensive use of this method will many of our older estates be able to grow another crop. A cover of vigna is not sufficient; material in large quantities will have to be buried.

RE-OPENING OF THE LAND: PREVENTION OF EROSION, ETC.

An opportunity such as this should be taken to do away with the old fields of varying size. The whole area should be divided up into uniformly sized blocks of as far as possible uniform shape. This is for convenience in future running. Manuring programmes, cultivation, etc., can be much more easily arranged and the land is divided up into blocks which would lend themselves to experiment should the occasion arise.

On re-opening old land it will obviously be of little use to take a lot of trouble over re-making the soil unless suitable measures are adopted to prevent further loss. Much has been written on the prevention of erosion and I propose to refer only briefly to the various methods. There are two factors which probably contribute more than anything else to soil deterioration, wind and water, the latter usually being considered the more important. The old square or rectangular system of planting with drains sloping at 1 in 40 did nothing to keep the soil in its place. Stone terraces held back the larger particles of sand and gravel but let through much of the finer particles and all the soluble part of the soil. The drains permitted of scouring and conducted a very large proportion of the water off the land. In the light of present knowledge the system has nothing to recommend it. Conservation of water in the soil is an important matter and for this reason as well as from an anti-erosion point of view surface run-off must be reduced or stopped completely.

There are now various well-known ways of preventing loss of soil but I look on contour planting in some form as a first essential where rubber is concerned. I favour the trench system of contour planting advocated by Mr. Denham Till. Here contour trenches 3 ft. by 3 ft. are cut at intervals of 20 to 24 ft. Lining is similar to any other form of contouring and it is preferable to mark off the agreed intervals between the successive contours down the hill at its steepest part. Adjacent contours will then always diverge, never converge. It is considered easier to insert short lengths where the divergence is too great than to break and start at a lower level when they come too close, one is also assured of a number of continuous contours.

During the cutting all the better soil, top soil with cover crops, is thrown uphill. This is used later for refilling purposes. The subsoil excavated is thrown out on the lower side of the trench to form a bund. Plants put in at 12 ft. intervals along such contours will give a stand of 120 to 150 trees per acre. In filling, portions of the trench only need be filled at the outset. Six ft. of trench should be filled for each plant, that is 3 ft. on either side of it. To prevent the refilled portion being washed down gradually into the intervening spaces the soil will have to be sloped so that actually a length of 8 or 9 feet will be filled at the bottom of the trench and gradually tailed off to 6 ft. at the top.

The unfilled portions afford excellent pits for the cheap burying of green manures and act as effective water traps. The green matter buried is exactly in the right place for use by the plant and so is the store of moisture.

The above system has all the erosion-preventing properties of the perhaps better known contour platform system and besides there is no check to growth caused by the roots filling the prepared hole and so becoming "pot bound."

Contour platform planting is probably next best. It is efficient as a prevention of erosion and it is less costly, at least in the first year. It does not however do away with the necessity of digging holes for the plants or pits for burying purposes.

It is thought that one or other of these methods is essential if success in replanting is to be obtained. The former method has to my mind many points to recommend it. The initial higher cost is balanced later by the extra cutting required in the other; the opening work except for burying of manure loppings is completed in one year.

In the event of lack of funds preventing the employment of either method much may be done to prevent soil movement by alteration and extension of the old drainage system. Drains sloping at 1 in 40 or so are best neglected but others with a more gentle slope may be re-cut and supplied with blocks, spills and water traps as has been described in a paper presented at a previous conference. Even here planting should be done on the contour. Generous holes will be required.

In all cases a thick growth of cover crops is essential but probably most essential where no terracing is done.

The wind factor in soil deterioration or this combined with sun must be counteracted. Winds, besides retarding growth of young plants, dry out the surface layer of soil and reduce bacterial activity. Great heat acts in the same way only probably in a more pronounced manner. Both can be controlled by shade, and ground covers of Gliricidias, Albizzias or some such small tree as *Leucaena glauca* will be essential in replanting schemes. Special wind belts may be necessary in certain cases and it may pay to leave temporarily belts of the old rubber augmented by Gliricidias in rows at intervals across the field. Regarding ground covers there is a big selection but where Vigna (*Dolichos hosei*) is already growing this will probably prove best and most easily established. Others are Calopogonium, Pueraria, and Cowpea which do not stand heavy shading and which must be regarded as temporary covers and *Centrosema pubescens* or *Indigofera endecaphylla* which if established in a clearing may persist reasonably well under older rubber.

PLANTING MATERIAL

All plants should be budded and only proved material should be used. A selection of clones may be made from the following, which are probably the most fully tested clones at present available: Tjirandji 1, 8, 16; AVROS. 49, 50, 71, 80, 152, 256; Bodjong Datar 2, 5, 10; Prang Besar 23, 25; SR 9; Cultuurtuin 88; Djasingha I.

A budwood nursery containing the selected clones will have to be laid down at least 18 months before the first supply of budwood is required, and in such a nursery six budded stumps will be required for each acre to be budded. Establishment of budwood nurseries is discussed in a booklet entitled "The Budding of Rubber" issued by the Rubber Research Scheme. Arrangements will also have to be made about 2 years ahead for seedlings for budding purposes. 300 seedlings should be allowed for each acre to be dealt with to allow of selection of the most vigorous.

LAYOUT OF THE LAND

About two years ago the advice given on planting material was to plant a mixture of budded plants and selected seedlings. More recently estates have been advised to plant budded plants only but to mix the clones. This shows increase in faith in budding but I prefer to go on further and recommend, when proved material only is being used, that different clones be kept strictly separate. It is quite possible and indeed probable that to get the best out of certain clones special mild, or it may be heavy, tapping systems will have to be employed. Where clones

are separate each can be treated on its merits; any admixture renders this impossible. The mixing of clones has been recommended with a view to future thinning out of the poorer trees, but thinning out in the case of budded rubber consists of the complete removal of poor clones. Is it not preferable, if such action is necessary, to have a piece of ground which can be replanted rather than an area which will suffer permanently from a deficient stand of trees per acre ? By the time it has been discovered that a certain clone does not come up to expectation it will be impossible to replace it with better material in a mixed stand. Further if really proved material only is used little if any thinning out will be necessary.

A plan of layout is suggested below which allows of clones being kept separate. If the land is divided up into 10 (or 20) acre fields a certain number of these can be allotted to each clone. In the diagram the fields are shown square but in actual practice the boundary fields will usually be irregular in outline. In such a scheme there would eventually be 10 fields or blocks of each clone all adjacent.

Budding is best done in the nursery where supervision is easy and therefore it will be most convenient to have the budwood nursery and seedling nursery in close proximity to each other.

The planting out of budded plants and the subsequent attention necessary are described in the previously mentioned booklet on "Budding."

AREAS PLANTED UP WITH UNSELECTED MATERIAL DURING 1925 AND 1926

I have been frequently asked whether young rubber 4 or 5 years old grown from unselected seed could be budded satisfactorily or whether it should be cut out and replaced. I am definitely in favour of making an attempt to bud such plants. The number of successes will be fewer but the growth of the plants when successfully budded is so vigorous that to my mind the extra trouble is worth while. Plants budded at this age will reach tappable size one year at least before budded stumps put out at the same time.

In such areas there will no doubt be plants which prove very difficult to bud: these will either have to be left or replaced with budded stumps.

In connection with the budding of such comparatively old plants there are one or two points which might be mentioned. "Green" budwood has proved preferable to the more mature brown wood. Also the "snag" left when the stocks are cut back requires more attention. This will have to be carefully cut back to the union of stock and scion as soon as the young budded shoot is 4 to 5 ft. high, in order to reduce as much as possible the "elephant foot." The cuts heal over satisfactory if protected by a waterproof coating of asphalt or tar.

CONCLUSION

Most points except actual costs have been touched on. A rough estimate, believed to be on the generous side has been drawn up and I propose to read this out item by item. Any information, which anyone present can give, will be welcomed as exact figures are not yet available. Discussion is invited and any questions raised will be answered as far as possible.

TAPPING ARRANGEMENTS DURING HEAVY TAPPING

It is assumed that an area is being replanted on a ten-year basis, one-tenth of the area being cleared each year. The unit of yield represents the yield which would be obtained from that area under normal tapping conditions.

Plots	1	2	3	4	5	6	7	8	9	10
1930	x	n	n	n	n	n	n	n	n	n
1931	x	x	n	n	n	n	n	n	n	n
1932	x	x	x	n	n	n	n	n	n	n
1933	≐	x	x	x	n	n	n	n	n	n
1934	0	≐	x	x	x	n	n	n	n	n
1935		0	≐	x	x	x	n	n	n	n
1936			0	≐	x	x	x	n	n	n
1937				0	≐	x	x	x	n	n
1938					0	≐	x	x	x	n
1939						0	≐	x	x	x
1940							0	≐	x	x
1941								0	≐	x
1942									0	≐
1943										0

n = tapped normally.
x = tapped both sides to normal depth.
≐ = final tapping.
0 = trees cut out.

EXPECTATION OF CROP UNDER HEAVY TAPPING SUGGESTED

(Previous Yield taken as 300 lb. per acre)

Plot ...	A	B	C	D	E	F	G	H	I	J	Total	
1930 ...	450	300	300	300	300	300	300	300	300	300	3150	
1931 ...	450	450	300	300	300	300	300	300	300	300	3300	
1932 ...	450	450	450	300	300	300	300	300	300	300	3450	
1933 ...	750	450	450	450	300	300	300	300	300	300	3900	
1934 ...		750	450	450	450	300	300	300	300	300	3600	
1935 ...			750	450	450	450	300	300	300	300	3300	
1936 ...				750	450	450	450	300	300	300	3000	
1937 ...					750	450	450	450	300	300	2700	
1938 ...						750	450	450	450	300	2400	
1939 ...							750	450	450	450	2100	
1940 ...								750	450	450	1650	
1941 ...	700								750	450	1900	
1942 ...	850	700								750	2300	
1943 ...	1000	850	700								2550	39300
1944 ...	1000	1000	850	700							3550	
1945 ...	1000	1000	1000	850	700						4550	
1946 ...	1000	1000	1000	1000	850	700					5550	
1947 ...	1000	1000	1000	1000	1000	850	700				6550	
1948 ...	1000	1000	1000	1000	1000	1000	850	700			7550	
1949 ...	1000	1000	1000	1000	1000	1000	1000	850	700		8550	
1950 ...	1000	1000	1000	1000	1000	1000	1000	1000	850	700	9550	
1951 ...	1000	1000	1000	1000	1000	1000	1000	1000	1000	850	9850	
1952 ...	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	10000	105000*

* Yield for the same period without replanting 69,000 lb.

COSTS

Complete removal of trees (including loppings of leafy twigs and stacking any firewood to be burnt (generous)	Rs. 150·00
Trench cutting, 30 chains @ Rs. 5/- (generous)	,, 150·00
Filling and making of Adco	,, 40·00
Cover crops, seed and planting	,, 15·00
Planting	,, 5·00
Weeding @ Rs. 12/- for 3 years	,, 36·00
,, @ ,, 4/- ,, ,, ,, ...	,, 12·00
Lopping green manures first year. ...	,, 4·00
,, ,, ,, subsequent years @ 5/-	,, 25·00
Budding @ -/05 per plant (excluding cost of budwood)	,, 6·25
Nurseries	,, 20·00
Seed @ -/01 each	,, 3·00
Baskets (?)	,, 2·00
Roads remaking	,, 10·00
Manuring 1st year	,, 6·00
,, 2nd ,, ...	,, 10·50
,, 3rd ,, ...	,, 19·50
,, 4th ,, ...	,, 19·50
,, 5th ,, ...	,, 30·00
,, 6th ,, ...	,, 38·00
	Rs. 601·75

A stump-removing wrench should be obtained and the cost distributed among the acres. This is included in the above.

It is presumed that unless the whole of an estate is being replanted there will be no general charges set down against the area in question.

PROBABLE DISTRIBUTION OF COSTS

Block		1	2	3	4	5	6	7	8	9	10	Total
Year.												
1931 1st	...	423'25	—	—	—	—	—	—	—	—	—	423'25
1932 2nd	...	27'50	423'25	—	—	—	—	—	—	—	—	450'75
1933 3rd	...	36'50	27'50	432'25	—	—	—	—	—	—	—	487'25
1934 4th	...	28'50	36'50	27'50	423'25	—	—	—	—	—	—	515'75
1935 5th	...	39'00	28'50	36'50	27'50	423'25	—	—	—	—	—	554'75
1936 6th	...	47'00	39'00	28'50	36'50	27'50	423'25	—	—	—	—	601'75
1937 7th	...	—	47'00	39'00	28 50	36'50	27'50	423'25	—	—	—	601'75
1938 8th	...	—	—	47'00	39'00	28'50	36'50	27'50	423 25	—	—	601'75
1939 9th	...	—	—		47'00	39'00	28'50	36'50	27'50	423'25	—	601'75
1940 10th	...	—	—	—	—	47'00	39'00	28'50	36'50	27'50	423'25	601'75
1941 11th	...	—	—	—	—	—	47'00	39'00	28'50	36'50	27'50	178'50
1942 12th	...	—	—	—	—	—	—	47'00	39'00	28'50	36'50	151'00
1943 13th	...	—	—	—	—	—	—	—	47'00	39'00	28'50	114'50
1944 14th	...	—	—	—	—	—	—	—	—	47'00	39'00	86'00
1945 15th	...	—	—	—	—	—	—	—	—	—	47'00	47'00
											Rs.	6,017'50

This means that assuming that each year's clearing extended to only one acre the total cost of bringing the whole 10 acres into bearing would be Rs. 6,017-50 distributed as above. As mentioned already this estimate is on the generous side.

TIME-TABLE

The one-acre blocks are labelled ABC - - - - J

Year	Tapping both sides	Final Tapping	Cut out	Bud-wood nursery	Plant supply nursery	Budding	Plant out
1930 ...	A			Plant			
1931 ...	AB			Bud	For A		
1932 ...	ABC			Bud	,, B		
1933 ...	BCD	A			,, C	For A	
1934 ...	CDE	B	A		,, D	,, B	A
1935 ...	DEF	C	B		,, E	,, C	B
1936 ...	EFG	D	C		,, F	,, D	C
1937 ...	FGH	E	D		,, G	,, E	D
1938 ...	GHI	F	E		,, H	,, F	E
1939 ...	HIJ	G	F		,, I	,, G	F
1940 ...	IJ	H	G		,, J	,, H	G
1941 ...	J	I	H			,, I	H
1942 ...		J	I			,, J	I
1943 ...			J				J

LAYOUT OF THE LAND

Year Planted (10-year programme)

CLONES	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	..
Tji 1	Tji 1 1930.										
Tji 16	Tji 16 1930.										
AV. 49	AV. 49 1930.										
AV. 50	AV. 50 1930.										
BD. 5	BD. 5 1930.										
BD. 10	BD. 10. 1930.										

THE CONTROL OF OIDIUM LEAF DISEASE

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INTRODUCTION

IN view of the depressed condition of the rubber plantation industry at the present time and the urgent necessity for retrenchment in every direction, I feel that an apology is due for reading a paper which is not directly concerned with economy in costs of production. Indeed it would seem that I am advocating the adoption of a measure which will add to the already overburdened expenditure of the rubber estate. An institute such as the Rubber Research Scheme, however, in addition to dealing with problems of immediate practical importance to the planter, must also look to the future and conduct researches which will be of ultimate benefit to the industry. Hence a great deal of attention has recently been devoted to the problem of controlling *Oidium* leaf disease, although it is unlikely that under present conditions many estates will adopt the method to be described, *i.e.*, dusting with sulphur powder.

STATUS AND ECONOMIC IMPORTANCE OF OIDIUM

The symptoms of *Oidium* leaf disease are now too familiar to need description in this paper, but before discussing control methods a brief survey of the status of the disease in the various rubber-producing countries may be of interest.

In Java the disease was first reported in 1918, and has increased in severity in successive years. At the present time it causes serious defoliation over thousands of acres during the weeks immediately following the "wintering" period, and has been one of the foremost subjects for investigation by Dutch scientific workers. In Malaya *Oidium* occurred for the first time in 1928. During the last two years it has spread to many districts and has now been declared a notifiable pest. The disease was first reported in Ceylon in 1925, being found simultaneously in most of the rubber-growing districts. It is now present on probably every estate in the Island, though the extent of defoliation caused by the fungus varies greatly in different localities. In the main low-country districts the fungus is active for a period of about two months from the middle of February to

the middle of April, and any tree which puts on new leaves during this period is attacked and partially defoliated. Owing to the fact that the fungus is passive during the remaining ten months of the year only a proportion of the trees is attacked to any serious extent, and these trees are able to recover by producing a secondary crown of foliage. On the other hand in certain mid-country districts, notably in parts of Matale and Uva, the virulent period is of far longer duration with the consequence that all trees are attacked and a process of continual defoliation results. In badly affected areas as large a proportion as 50% of the trees may be found to be completely defoliated.

It is indeed fortunate that *Oidium* should have attained this severity not in the main low-country rubber-growing districts, but in the mid-country where rubber growing is relatively unimportant to the Island as a whole. It seems probable that the climatic conditions in the wet low-country districts are unfavourable to prolonged activity of the fungus so that extensive defoliation is not to be expected. The possibility, however, of the disease becoming more serious in these localities must be kept in view, and it was therefore considered very necessary that the control of *Oidium* should be investigated.

At this stage it will be well to consider the economic significance of *Oidium* in Ceylon. The importance of *Oidium*, as of any other disease of *Hevea*, must ultimately be judged by the loss in yield entailed. A costly method of disease control will not commend itself to the planter and estate proprietor unless it can be shown (1) that the disease, if allowed to remain unchecked, will eventually cause losses in yield; (2) that the control method is effective; and (3) that the comparative increase in yield of the treated rubber compensates for the expenditure involved. The first two points are dealt with in this paper. As regards the third no reliable figures are yet available, and the financial aspect of the treatment must necessarily depend, to some extent, on the selling price of the commodity.

There is at present a lack of reliable information regarding the effect of severe *Oidium* attack on yield. In Java, where the disease has caused serious defoliation for many years, considerable decreases in yield have been reported, though I have seen no scientific data on the subject. In Ceylon no decreases in yield have, so far as I know, been attributed to *Oidium*, and it is hoped that yield records which are being kept on a badly affected estate will elucidate this point. Surprise may be expressed at the ability of a severely defoliated tree to yield an apparently undiminished flow of latex, and in endeavouring to find an explanation we are unfortunately handicapped by our ignorance of the function of latex in the tree. There

can be little doubt that abnormal defoliation is seriously detrimental to bark renewal, and the full effect of *Oidium* will therefore not be apparent until the bark is being tapped that has renewed during the years in which the disease was active. On no estate in Ceylon has *Oidium* been severe for more than about four years, and during these years the bark that has been tapped was fully renewed while the foliage was healthy. Resting due to restriction has resulted on most estates in the possession of large reserves of bark so that the effect of poor renewal during the past few years has not yet been in evidence. It is anticipated that unless control measures are taken the yield of severely affected estates will soon show a decrease which will become more marked in successive years. The evils of poor bark renewal are familiar to all rubber planters, and the desirability of adopting efficient measures to control the cause thereof will therefore be appreciated.

CONTROL

In the control of a leaf disease there are always three possible lines along which research may be conducted: (1) by breeding immune or resistant varieties of the host plant; (2) indirect control by cultivation methods; (3) direct control by killing the causative fungus. I will deal briefly with the first two considerations before describing in some detail the method of sulphur dusting.

(1) *Breeding immune or resistant varieties.*—If an immune variety or species were found it could be grafted on to a high-yielding stock so that the composite tree would possess an immune crown of foliage. There is at present, however, no evidence of any inherent immunity or resistance amongst individual trees of *Hevea brasiliensis*. In Java, Bobilioff has bud-grafted three different species of *Hevea*, *H. collina*, *H. guyanensis*, and *H. spruceana* high up on stocks of *H. brasiliensis*, and these buddings have been planted out on two estates heavily infected with *Oidium*. Now, however, that an effective method of controlling the disease has been found it is doubtful if these composite plants will be of commercial value.

(2) *Indirect control by cultivation methods.*—It is a well-established fact that the application of nitrogenous manures benefits the foliage of rubber, and recent experiments and observations in Ceylon and Java indicate that trees manured in this way, while no less susceptible to attack by *Oidium*, are better able to recover from the effects of the disease. In severely affected areas, however, where *Oidium* causes a process of almost continual defoliation throughout the year, the adoption of manuring and other cultivation methods is of little value. Where the period of virulence is short nitrogenous manures will assist the

tree to put out a secondary crown of leaves to replace the foliage destroyed by *Oidium*, but in badly affected areas this secondary crop will also be attacked and therefore the value of the manures lost. Heavy nitrogeneous manuring delays the wintering period and in some localities it may thus be possible to postpone the time of refoliation until the fungus is inactive.

To summarise these remarks, the application of nitrogeneous manures to severely affected areas is not recommended, although on more mildly affected estates the worst effects of the disease may be largely ameliorated.

(3) *Direct control by killing the causative fungus.*—For effective control of a fungus disease by the application of a fungicide three conditions must be satisfied. First, the fungicide used must be highly toxic to the causative organism; secondly, the technique must be such that the fungicide reaches the necessary parts of the host plant; and thirdly, the application must be made at the right time in relation to the life-history of the fungus and of the host.

In the search for an effective means of controlling *Oidium* the first of these provisions was easily satisfied, since experience with diseases caused by other powdery mildews has shown that sulphur, in one form or another, is the most effective fungicide. The problem of applying sulphur to the foliage of the rubber tree was, however, less easily solved. The first experiments were carried out in Java with Sulfinette, a lime-sulphur preparation. Spraying with this fungicide was found to give a certain measure of control but was relatively unsatisfactory owing to the high cost of the treatment. Liquid spraying of *Hevea* must necessarily be an expensive, slow and troublesome operation owing to the difficulty of projecting a fine spray to the required height. The operation is largely dependent on a ready supply of water, and on some estates the cost of transporting water would be prohibitive. The average cost of spraying rubber with Sulfinette is about Rs. 15-00 per acre, an area of about 1-1½ acres being treated in a day.

The problem, therefore, was to find a method of spraying sulphur which was effective, cheap, quick and universally applicable.

SULPHUR DUSTING

As the result of some years of experiment the Dutch workers in Java evolved the method which is now regarded as the standard treatment for controlling *Oidium*. It was clear that if finely powdered sulphur could be applied in a dry form the problem of the supply and transport of water would be eliminated. Dusting from aeroplanes was given a trial but although good results were obtained this method has, I understand, been

discarded on account of the cost. The method now adopted consists, in brief, of projecting upwards a cloud of finely divided sulphur powder by means of a small power machine which can be carried through the estate by coolies. At this stage it may be stated that the method has been used with great success over thousands of acres in Java during 1929 and 1930, but that in Ceylon it is still in the experimental stage. Owing to different conditions of environment, climate, etc., in the two countries the problems of *Oidium* control are not identical in detail, and further experiments are necessary before the same degree of control is obtained in Ceylon as in Java. Experiments which have so far been carried out have given very promising results, and have shed light on many important points.

The Dusting Machine.—The machine which has been mostly used in Java and in our experiments in Ceylon is the Björklund Duster. The power is supplied by a two-stroke petrol engine which drives a fan at high speed. Sulphur is admitted to the fan chamber from a hopper with a feed regulator and is blown up through a chimney. The whole forms a compact unit mounted on an iron stretcher, and is slung from poles and thus carried on the coolies' shoulders. This machine has proved to be very efficient and economical to run. Other dusters are on the market, and an experimental machine of British manufacture has recently been tested in Ceylon.

The Sulphur.—It is essential that very finely divided sulphur be used since the success of the dusting operation is entirely dependent on the cloud-forming properties of the powder. Broadly speaking two suitable forms of sulphur are available: (1) Volcanic sulphur from Java, which needs sun-drying and sifting before use; and (2) specially prepared dusting sulphur of which American firms appear to have the monopoly. American sulphur can be used without any preliminary drying or sifting. It is more expensive, however, than the Java product, and it is doubtful if the saving in the labour of drying and sifting compensates for the higher initial cost.

The Dusting Operation.—For the dusting operation ten or twelve coolies are required according to the nature of the ground. It is usually possible to treat the greater part of a field from the paths or roads, but it is occasionally necessary to negotiate rough and steep ground. Although four coolies can carry the machine on flat ground it is usually desirable to have six or eight coolies available for this purpose. The remainder are employed in carrying the sulphur and feeding it into the machine.

The engine is started, sulphur fed into the hopper, and the dusting is in progress. The machine is carried, while working, along suitable paths or lines, the output of sulphur being regulated according to the strength and direction of the wind, the lie of the land, and the rate of progress. The sulphur is ejected in the form of a cloud of very fine particles similar in its behaviour to smoke. The distance to which the sulphur carries, and therefore the working range of the machine, is dependent on the strength of the wind. On a still day the sulphur rises very high and often forms a cloud above the tops of the rubber trees. Under such conditions the machine has a small range of action and the dusting process is comparatively slow. A strong wind is unfavourable unless blowing down a steep slope since the sulphur does not then rise sufficiently high. The ideal conditions are a slight steady breeze which permits the sulphur to rise to a sufficient height and at the same time wafts it slowly through the foliage. If such a breeze is blowing across the direction in which the machine is being carried a distance of about 100 yards can be effectively dusted from each line. The problem of applying the dust to every portion of a rubber field is not one on which any hard and fast rules can be laid down. Every area must be treated on its own merits in accordance with the local and wind conditions obtaining at the time. As the result of experiments which have recently been carried out on steep land in Uva I have come to the conclusion that it is of great importance that every little corner of a field be adequately treated. This is often a matter of extreme difficulty on steep and rocky ground, but if necessary the acreage covered in a day must be sacrificed in order to ensure that every portion receives its full quota of sulphur. As far as cost is concerned the acreage treated in a day is relatively unimportant since the cost of the operation lies almost entirely in the sulphur. Under favourable conditions on well roaded land an area of 100 to 150 acres should be covered in a day, but on steep land, such as is common in the mid-country districts of Ceylon, 50 acres is a more probable figure.

Such questions as the minimum effective quantity of sulphur per acre, the number of applications and the period elapsing between successive applications must be subjects for further investigation, and will depend largely on the severity of the disease. In Java the first application is made immediately before the outbreak of *Oidium* on the young leaves produced after "wintering." A careful watch is kept for signs of renewed activity, and as soon as the disease is seen a second application is made. This probably follows two or three weeks after the first dusting. This process is continued during the two or three months in which the fungus would naturally be virulent, a total number of five or six applications probably being made. The

quantity of sulphur used is about 10 to 12 lb. per acre, though further experiments are being carried out to discover the minimum effective dose.

In Ceylon the optimum time to commence dusting provides a more difficult problem, since in badly affected areas the fungus is active throughout the year. Even in such localities, however, a period of maximum virulence covering the time of normal refoliation is evident, and dusting should probably be commenced at the first advent of young leaf after "wintering." Subsequent applications should be made at approximate fortnightly intervals until all the trees are in mature leaf. The problem is complicated by the fact that in the mid-country districts of Ceylon normal wintering is irregular and protracted so that for several months there is abundant young leaf and flower which the fungus can attack. In the experiments which have so far been carried out in Ceylon about 12 lb. of sulphur per acre per application have been applied. There is evidence, however, that in the most severely affected areas this quantity is insufficient, and it is probable that a greater quantity of the fungicide should be used at least in the first one or two applications.

Results.—In dealing with the most important aspect of sulphur dusting, *i.e.*, the results obtained, I will first refer to the work in Java. As regards the effect of dusting on increased rubber production very few figures are yet available. The only figures I have seen indicate an increased yield of over 50% on dusted as compared with undusted plots. I am not, however, disposed to place much reliance on these figures since the experiment has been in progress for too short a time. There seems no doubt that as regards foliage the dusting treatment has achieved phenomenal success in Java. Almost 100% control is claimed, only slight secondary attack being evident, while the abundance of flower, and subsequently seed, in dusted areas is a striking feature.

In Ceylon we cannot yet claim to have achieved so great a measure of success. Yield records are being taken from plots in neighbouring dusted and undusted fields, but these have not yet been in progress for a sufficiently long time for any conclusions to be drawn. In the absence of evidence regarding the value of sulphur dusting in respect of yield attention must be confined to its effect on the foliage.

A number of photographs* have been taken illustrating the benefit to the foliage due to sulphur dusting. These are passed round for inspection, and are readily understood by reference to the explanatory footnotes.

* Photographs not reproduced.

As an additional means of judging the results of the treatment a series of light tests was taken in a dusted and a control field. The method consists of exposing a small circular area of photographic printing paper to the light for a certain specified time, the depth to which the paper is tinted being proportional to the intensity of the light. Provided, therefore, that the intensity of the light is constant the depth of tint is inversely proportional to the amount of shade caused by the foliage. The results of the light tests taken in a number of plots in a dusted and a control field is shown in the photograph* exhibited. It will be seen that the discs relating to the control rubber are darker in tint than those exposed under the dusted rubber, thus showing that the dusted foliage was denser than the control.

Other methods have been used to demonstrate the benefit due to dusting, and certain figures were given in a previous publication issued as Leaflet No. 11 of the Rubber Research Scheme (Ceylon.)

To summarise the results obtained in the experiments which have so far been conducted in Ceylon, a considerable benefit to the foliage has been secured, though the fungus has by no means been completely controlled. It was not to be expected that the first experiments on an entirely new treatment such as sulphur dusting should be completely successful. Various reasons for the failure to secure complete control have been deduced, and these points will receive special attention in future experiments.

Quantities and Costs.—The cost of the highest grade of Java volcanic sulphur is about 6½ cents per lb. f.o.r. Colombo for quantities of ten tons and over. The cost of making one application of sulphur on the basis of 12 lb. per acre and 100 acres per day works out at about Rs. 88-00 per day, or 88 cents per acre, made up as follows:

		Rs.	cts.
1200	lb. Sulphur @ -/06½ cts. per lb. ...	78	00
12	coolies for carrying duster and sulphur @ -/60 cts	7	20
1½	gallons petrol-oil mixture ...	3	00
		88	20

This excludes depreciation on the machine and the expense of special supervision. It will be seen that the cost of the operation lies almost entirely in the sulphur, the labour and the running expenses of the machine being very small items. On severely affected estates it is probable that six applications would be necessary at a cost of about Rs. 5-00 per acre.

CONCLUSIONS

I have endeavoured in this paper to indicate first the necessity for undertaking control measures on estates severely affected with *Oidium*, and secondly a method by which control may

* Photographs not reproduced.

be secured. Although sulphur dusting is still in the experimental stage in Ceylon there is no doubt that it is a quick, effective, and comparatively cheap means of control. There are still many points which only further experiment can elucidate. For example, it is not known to what extent dusting will be a permanent cure, and whether it will be necessary to carry out the treatment every year. It seems probable that if concerted action were taken by all estates in a badly affected district the fungus would, in a few years, be to a large extent stamped out and could be kept under control at a small expense. It is hoped that interest in sulphur dusting will be stimulated by a recovery in the price of rubber.

The results of the most recent dusting operations in Java are not yet available, and it is possible that some of the statements I have made will need to be modified in the light of future experience.

ACKNOWLEDGMENT

In conclusion, I should like to express my gratitude to the Superintendents of Bandarapola, Kandanuwara and Gonakelle Estates whose assistance and co-operation in the sulphur dusting experiments has been of great value.

DISCUSSION

His Excellency the Governor said he felt sure that many members would like to ask questions or make observations on the subject.

Mr. T. H. Holland desired to know whether the leaves were wet or otherwise during the application of sulphur.

Mr. Murray said that dusting of sulphur was usually undertaken during dry weather, when the leaves were not wet except perhaps with dew in the early morning. He understood, according to work carried out in Java, that the sulphur was just as effective if dusted on wet leaves as on dry.

Mr. Robert De Zoysa said that he was interested in the economic side of the question and wished to know whether the 12 lb. of sulphur per acre was irrespective of the number of trees treated.

Mr. Murray said that it was not practicable to treat individual trees. The method employed was to throw up a cloud of dust which was carried some distance by the wind.

Asked as to the duration of the effect of sulphur, he said that this was a point on which there was still no definite data. The treatment was carried out during a period of *Oidium* attack, roughly speaking once a year, and on the young leaf immediately after wintering the dusting being repeated at fortnightly intervals. Another way of answering the question might be to state that sulphur remained active as a fungicide on the leaf for about ten days after dusting.

Mr. R. G. Coombe invited the lecturer's attention to his remark regarding conditions in the mid-country, particularly Uva, and asked whether Mr. Murray would recommend the application of sulphur on the old foliage as on trees which had just come back from wintering.

Mr. Murray said that on matured leaves the fungus was found active in what was known as "secondary attack," but it was also in a passive state throughout the year, and whether a fungus could be killed in its passive state was not yet known, but he thought that treatment would probably not be effective at all. He therefore thought that it would not be of much value to apply sulphur on trees before they had wintered. This was a point for experimentation and indeed the whole process was in an experimental stage in Ceylon at present.

Mr. Coombe then enquired as to the cost of the machinery.

Mr. Murray replied that a machine cost 825 gilders in Java, which worked out at rather over Rs. 900 in Ceylon.

Mr. Gordon Pyper desired to know whether any danger was to be anticipated of infection of the soil through falling of the leaves attacked by *Oidium*.

Mr. Murray thought not owing to the character of the fungus, but there was a possibility that fallen leaf might give rise to infection if the fungus had formed spores which were able to withstand desiccation.

In reply to Mr. Pyper's question as to whether there was a possibility of cover crops being affected, Mr. Murray said that there was no evidence at present that the fungus which attacked rubber leaves could also attack any of the cover crops. There was an *Oidium* which had been found to attack Vigna, but that he did not know whether it was the same which attacked rubber or not, for although structurally the same they might be biologically different.

Mr. Ragunathan asked whether there were figures of comparative yields of sprayed and unsprayed plots.

Mr. Murray said that an experiment to determine the point was being carried in the Matale district and yields were being recorded from dusted and undusted fields. So far there were no results but he doubted whether there could be any increase of yield in treated areas for some time yet.

Mr. R. Smerdon wished to be informed whether there was any hope of sulphur dusting being effective against *Phytophthora* too.

Mr. Murray thought not, because in the first place dusting against *Oidium* was undertaken at a time of the year when *Phytophthora* was not active. Sulphur again was not active against *Phytophthora* in the same way as against *Oidium*. In further reply to Mr. Smerdon he said *Oidium* would attack trees of any age.

H. E. The Governor thanked Mr. Murray for his paper and he hoped that before long the rubber industry might be in a position to take advantage of the excellent work which was being done for the industry.

REPORT ON SULPHUR DUSTING EXPERIMENTS ON GONAKELLE ESTATE

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1. *The Experimental Area.*—The total area of rubber on Gonakelle Estate is 93 acres, consisting of three fields of approximately 45, 40, and 8 acres respectively. The latter field is situated about $\frac{1}{4}$ mile distant from the main portion of the rubber, and served as an untreated control in the dusting experiments. Roughly speaking, the two main fields consist of relatively narrow strips planted down a steep hillside from an elevation of over 3,000 feet down to about 1,500 feet. Whereas one field is well roaded, having a path "zig-zagging" from the top to the bottom, the other has few paths, such as there are being badly placed for dusting purposes. This matter has an important bearing on the success of the operations, as indicated below.

The rubber is mature and well grown for so great an altitude, and has not been tapped for some years. Before the dusting was commenced the intensity of *Oidium* was judged to be approximately equal in the three fields, the extent of defoliation being, perhaps, slightly less in the control block. Every tree was affected to a greater or less degree, and it was estimated that approximately 30% of the trees had been completely defoliated. The fungus was active when dusting was commenced.

2. *The Dusting Operations.*—For the most part the Björklund Duster was used, as in the experiments in Matale. With the exception of a few minor points due to the vibration of the two-stroke engine the machine gave entire satisfaction. In conjunction with the dusting experiments a trial machine of British manufacture was tested.

Two kinds of sulphur were used:

(1) "Acme 300" sulphur dust manufactured in America.

(2) "Flotate" sulphur from the Kawah Poetih volcanic deposits in Java.

The price of the American sulphur f.o.r. Colombo is about 13½ cents per lb., whereas for the Java product the corresponding cost is about 6½ cents per lb., the difference in price being largely due to the heavy freight charges from America. The only advantage which the American sulphur appears to possess is that it may be used without any preliminary treatment. "Flotate" sulphur, on the other hand, must be dried in the sun for a few hours before use, and may be passed through a sieve to advantage. This operation, however, costs not more than about 1/10 cent. per lb., so that it would appear that the extra cost of the more specialised product is not justified. When satisfactorily dried "Flotate" sulphur possesses as good cloud-forming properties as "Acme 300," and its fungicidal properties appear to be at least as good. The conclusion that "Flotate" sulphur is preferable to "Acme 300" should not be interpreted as a general statement unfavourable to specially prepared American sulphurs. Price is a very important factor, and if an American firm can place on the Ceylon market a suitable article at a price competitive with that of Java sulphur, its use must be considered. At the present time it is not known whether the Java sulphur possesses any advantages over American sulphur on account of its acid content.

A total quantity of 6,200 lb. of sulphur was applied to the experimental fields on Gonakelle, 4,000 lb. of "Acme 300" dust being first applied in four applications followed by 2,200 lb. of "Flotate" sulphur in three applications. In all an average of 73 lb. per acre was applied. Mechanical trouble with the experimental machine somewhat interfered with the later dusting operations, with the result that portions of the rubber have received 7 applications while others have had only 6 dustings. The first application was made on May 7th, and 8th, 1930. Subsequent dustings followed at approximate fortnightly intervals, the final application being made on August 19th, and 20th.

Owing to the steepness of the land and scarcity of the paths in part of the experimental area each application occupied two days, so that an average area of only 42½ acres was treated per day. The dusting operation was confined to the mornings. The coolies were seldom able to return to the lines before about 2 p.m. and were not, therefore, required to work in the afternoons. All the work was personally supervised.

3. *Quantities and Costs.*—The following figures represent the approximate costs of the dusting operations on Gonakelle. It is impossible to give exact figures owing to the complications introduced by the testing of the experimental British machine. The figures are of little value as a gauge of the general cost of

sulphur dusting owing to the excessively high price of the American sulphur. Depreciation of the machine and cost of special supervision are not included.

			Rs.	cts.
Sulphur.	(1)	4000 lb. "Acme 300" @ 13·3 cts.	532	00
		2200 lb. "Flotate" @ 6·6 cts.	145	20
	(costs are excluding transport from Colombo)			
Labour.		140 coolies @ -/60 cts.	84	00
Petrol.		7 gallons @ Rs. 1-75	12	25
Oil.		1½ gallons @ Rs. 4-50	6	75
		Rs.	780	20

This is equivalent to about Rs. 9-25 per acre. It is again emphasised that this figure does not represent the economic cost of sulphur dusting in Ceylon.

4. *Results.*—Before reporting the results of the dusting experiments it is necessary to consider the condition of the foliage when the dusting was started and during the course of the operations. The normal "wintering" process occurs on Gonakelle during February, March, and April. When dusting was started on May 7th most of the trees had put on their new foliage and had suffered as the consequence of a severe *Oidium* attack. It was estimated that about 30 per cent. of the trees had been completely defoliated. These trees put out a second crown of foliage during the course of the experiments, so that there was at all times a proportion of the trees in young leaf. In addition a considerable percentage of trees underwent a secondary "wintering" in July and August so that there was a large quantity of young leaf in August and early September. This secondary "wintering" is normal in parts of Uva and is doubtless due to a prolonged period of dry weather following the N. E. Monsoon.

Oidium was active throughout the course of the experiments but did not cause as severe leaf-fall as in March and April. It became more virulent in the control field after the normal secondary wintering referred to above, and its increase in virulence appeared to be associated with the advent of showery weather.

It may at once be stated that the benefit in the foliage due to the sulphur dusting was disappointing. This is considered to be chiefly due to the fact that the dusting was carried out at the wrong time of the year. It was the intention to commence dusting early in April, but owing to unforeseen delays in shipping the sulphur from America, the start was postponed until May 7th, by which time the foliage had already suffered severely from the disease. As far as the control of the fungus is concerned, however, very definite results were obtained.

In considering the results of the dusting it is necessary to distinguish between the two treated fields. It has already been mentioned that whereas one field is well "roaded," the other is poorly provided with paths. In order to determine whether it is necessary to apply the sulphur carefully to every portion of the rubber, or whether, once a good cloud of sulphur has been projected, the breezes will effectivly distribute it to all parts, the latter area was dusted chiefly from such paths as existed. As a consequence the treatment was comparatively ineffective, and only those portions of the field to which the sulphur could be easily applied have benefited to any marked extent. The valuable conclusion is drawn that it is of the utmost importance to ensure that every portion of the rubber receives its full quota of sulphur. On steep land this is often a matter of great difficulty, and would probably be a limiting factor to the success of sulphur dusting on some mid-country estates. Attention is directed below to the results obtained on the well "roaded" field in which it was possible to dust every portion from the paths.

Owing to the lie of the land it was found difficult to obtain satisfactory photographs of this and the control field to demonstrate the appearance of the foliage. Two photographs of the same portion of the dusted field are shown, No. 1 being taken on May 21st., *i.e.*, two weeks after the first dusting, and No. 2 on September 5th., two weeks after the final dusting. A marked improvement in the foliage due to the treatment is evident. It is to be noted that so striking an improvement was not noticeable in every part of the field.

In order to compare the foliage in the dusted and control fields the light test method described by R. A. Taylor in R.R.S Quarterly Circular 1929, Vol. 6, No. 2 was employed. "The amount of shade under the trees is estimated by comparing the depth of tint obtained when pieces of photographic daylight printing paper are exposed for known lengths of time, the depth of tint being inversely proportional to the amount of shade and consequently to the density of the foliage cover." The frame designed by Taylor was used. Twenty measurements were taken, ten in the dusted and ten in the control field. The ten plots in each field were chosen at random, and are considered to be representive of the fields as a whole. The same length of exposure was given in each case, the light being uniformly bright. Photograph No. 3 is a reproduction of the sheet obtained; it is seen that the discs relating to the dusted field are lighter in tint than those taken in the control fields, thus demonstrating the superiority of the dusted foliage.

The foliage of the dusted and control fields was carefully examined on September 4th and 5th, and the following points were noted:

(1) In the dusted field about 15 per cent. of the trees were or had recently been in young leaf, and in every case examined the preceding defoliation was of the normal secondary type described above. In the control field the corresponding proportion was about 30 per cent. the defoliation in about half these cases being due to *Oidium* attack in the previous month or two.

(2) In the dusted field 38 trees in young leaf were examined, and in every case *Oidium* infection was either absent or slight. Leaf-fall was negligible. In the control field 48 such trees were examined, *Oidium* infection being classed in all cases as moderate or severe. The extent of leaf-fall was considerably greater than in the dusted field.

(3) There was an abundance of healthy flower in the dusted field, and a small quantity in the control.

(4) A small number of trees in the dusted field which had refoliated during the dusting operations appeared to be quite free from the disease, while, of a total of 240 trees examined, 31 per cent. showed only mild secondary attack. In the control field no entirely healthy trees were found, and the proportion with mild secondary attack was 10 per cent.

(5) A large percentage of trees in both areas possessed a thin crown of distorted leaves, mainly the result of *Oidium* attack before the dusting operations were commenced.

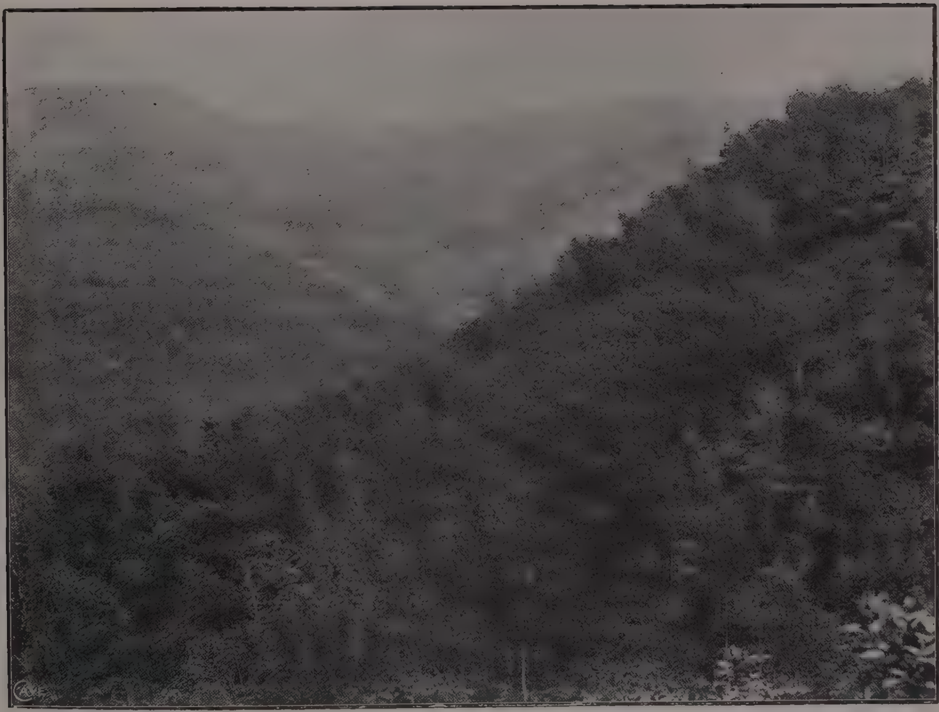
The above remarks apply only to the control field and the well "roaded" dusted field.

5. *Conclusions.*—As the result of the dusting experiments and other observations on Gonakelle the following conclusions have been drawn:

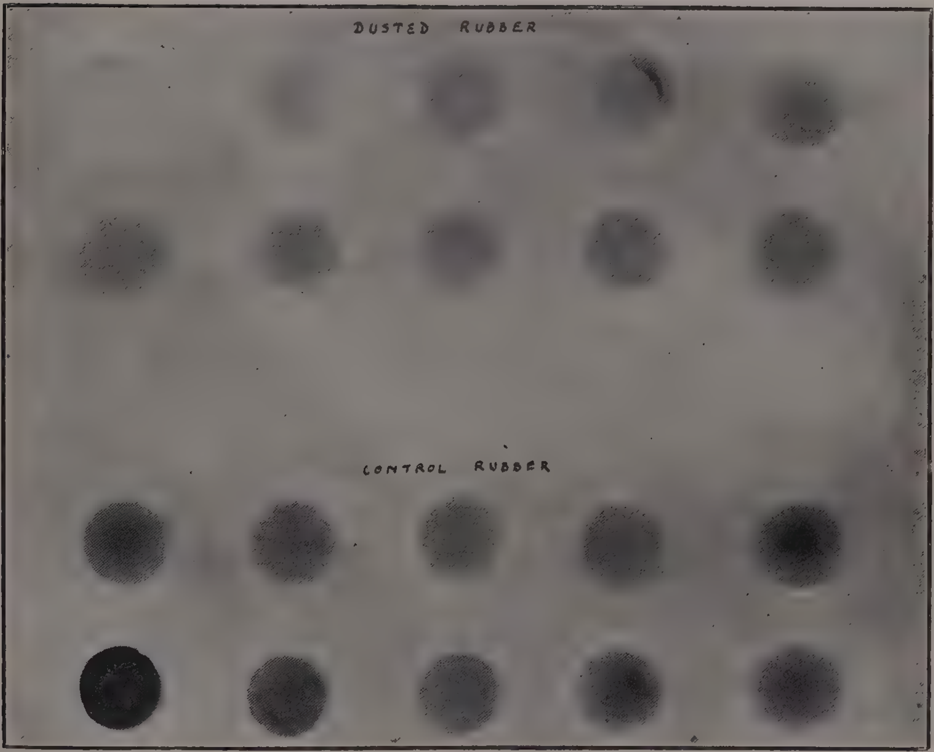
(1) "Flotate" volcanic sulphur from Java is as effective a fungicide as the more specially prepared "Acme 300" dust from America, and is preferable on account of its cheapness.

(2) In order that the dusting operations should achieve the maximum success they should be carried out during the period of refoliation after the normal "winter." The applications on Gonakelle were started too late in the year. It is probable that the first application should be made at the first appearance of young leaf after "wintering." This matter is to be investigated in further experiments to be carried out in Matale.

No. 1.—Gonakelle Estate. Portion of rubber, before dusting. May 21st, 1930.



No. 2.—Gonakelle Estate. Same view as No. 1, after dusting. September 5th, 1930.



No. 3.—(See Text.)

(3) The importance of ensuring that every portion of the rubber receives its full dose of sulphur is stressed. Steep land with few convenient paths may be very difficult and slow to dust effectively.

(4) Severe attacks of *Oidium* appear to be associated in the Passara district with showery weather. This may appear at first sight to be contradictory to the previous conclusion that a dry atmosphere is the most important climatic factor favouring the disease. It must be noted, however, that Passara is a dry district, and the humidity between showers is relatively low. It is possible that the showers provide the quantity of moisture necessary to the vegetative growth of the fungus mycelium, the intervening dry spells being favourable to the production of the conidia.

(5) Although the dusting operations, as judged by the general appearance of the treated rubber, cannot be considered highly successful, it is considered that the experiments, as such, have fulfilled a useful purpose in elucidating several problems in connection with the treatment.

6. *Acknowledgment.*—Thanks are due to Mr. G. Kent Deaker, Superintendent of Gonakelle Estate, for his kind co-operation in these experiments.

REPORT ON THE EFFECT OF ADDING SODIUM BISULPHITE TO LATEX ON THE PLASTICITY OF CREPE

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AND

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DURING an investigation into the causes of variability in plasticity it was shown that the addition of sodium bisulphite to latex resulted in the production of a harder type of crepe than that obtained without bisulphite (Bulletin No. 49 p. 5). This is an observation which it is desirable to confirm, not because it may lead to the omission of bisulphite in crepe manufacture, but because it may be of value in determining the fundamental factors affecting the plasticity of rubber and so lead to better methods of control.

As the maximum amount of bisulphite used in the experiment did not exceed that recommended by the Rubber Growers' Association, it was decided in the confirmatory experiment to use still larger quantities with a view to determining the maximum effect of bisulphite on plasticity, although estates are unlikely to use large amounts owing to subsequent difficulty in dyring the crepe.

Three samples were accordingly prepared, one containing no bisulphite, another the amount commonly used on estates and the third double that amount.

On arrival in London the samples were submitted to a hardness test at 100°C and in agreement with previous results the hardness of the samples was found to be proportional to the amount of bisulphite added to the latex.

As the plasticity of rubber may change considerably on keeping portions of the samples were stored at 32°F and 60°F

for six months and then tested for hardness and plasticity. The results of the tests are shown in the following table:

Sample No.	Amount bisulphite added to latex	Before storage D30	After storage for six months at 32°F D30	32°F Mastication Number	60°F D30	60°F Mastication Number
		mm./100	mm./100		mm./100	
1493	nil	147	157	88	158	87
1494	normal (1:266)	155	170	100	168	99
1495	twice normal (1:133)	174	169	105	169	103

These results confirm that the addition of bisulphite to latex renders the crepe more difficult to masticate. When the normal amount is used the mastication required is increased by nearly 15 per cent and when twice the normal amount is used the amount of mastication required is further increased by approximately 5 per cent. The temperature of storage has had little effect on the hardness or masticating properties of these samples.

It is not obvious why the addition of small quantities of bisulphite to latex should cause crepe to become hard. Information on this point may be of value in solving the general problem of the cause of variation in the plasticity of estate rubber.

Chemical tests were therefore carried out to determine whether there is a relationship between the hardness of the samples and (a) the amount of mineral matter present, (b) the amount of moisture in the rubber and (c) the acidity of some of the non-rubber accessory substances.

The results obtained are shown in the following table:

Sample No.	Proportion bisulphite: dry rubber	D30	Moisture*	Ash	Acid value Water-soluble	Acid value Acetone-soluble
		mm./100	per cent	per cent	mgrm./KOH	mgrm./KOH
1493	nil	147	0·17	0·20	48	201
1494	1:266	155	0·20	0·18	44	207
1495	1:133	174	0·25	0·18	50	174

* After keeping ten days over 50 per cent sulphuric acid, *i.e.*, in an atmosphere nearly 40 per cent saturated with moisture.

The results indicate that although the addition of bisulphite to the latex has a distinct hardening effect on the rubber this is not related to the amount of mineral matter in the rubber, or to the acidity of the water-soluble substances or of the acetone-soluble substances. The addition of bisulphite to the latex does not appear to have increased the total amount of mineral matter in the rubber, but, as expected, it has led to an increase in the

hygroscopic material, so that when exposed to the same humidity conditions the sample containing most bisulphite contains the largest amount of moisture. It is of interest in this connection to note that the sample containing most bisulphite required one day longer than the others to dry. It is unlikely however that the effect of bisulphite in hardening the rubber is connected with the amount of moisture present as unpublished investigations at the Imperial Institute show that moist rubber (unless it becomes mouldy) has less tendency to harden on keeping than dry rubber.

These chemical investigations have not succeeded therefore in suggesting a definite reason for the hardening due to bisulphite. A study of the effect on the hardness of crepe of compounds similar and related to bisulphite has been arranged which it is hoped will furnish more definite information.

SUMMARY

Experiments are described which show that the addition of bisulphite to latex renders the crepe harder and more difficult to masticate in proportion to the amount added.

The results of preliminary chemical tests do not suggest an obvious reason for the difference in plasticity due to bisulphite, but arrangements have been made to prepare further samples in which compounds related to bisulphite are added to the latex with a view to obtaining further information as to the cause of the hardening due to bisulphite.

REPORT IN CONNECTION WITH VISIT TO THE EAST

A COMPARISON OF METHODS OF PREPARING PLANTATION RUBBER IN CEYLON, MALAYA AND JAVA

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FUNDAMENTAL factors which may affect the preparation and properties of rubber in the three countries are differences in type of soil and differences in temperature and humidity.

Soil.—In Ceylon most of the rubber is grown on undulating land some of which is covered with huge boulders. Neither in Malaya nor Java are conditions so hilly. The impression gained was that agricultural operations and latex collection are difficult in Ceylon, somewhat easier in Malaya and least difficult in Java. There are considerable differences in the appearance and physical texture of the soil in the three countries, but no opinion of value as to their comparative fertility could be formed in the short time available.

Climate.—The temperature in the rubber growing districts of Ceylon is about 5° lower than in Malaya and Java. For this reason fermentation of latex does not occur so readily in Ceylon. The lower temperature affects the growth of the trees and the rate of bark renewal. The trees take longer to reach maturity in Ceylon and it is customary during tapping to take much thinner shavings than elsewhere to allow for slower bark renewal.

Although the rainfall is abundant in all three countries the atmosphere in Ceylon is not so heavily charged with moisture. Crepe rubber can therefore be dried in less than a week when the weather is favourable, whereas in Java* it is necessary to employ artificial heating at night-time and in Malaya great care is necessary with regard to the position, dimensions and ventilation of the drying room.

During my visit there was a considerable amount of morning rain in Ceylon which interfered with tapping. The tapping intervals were therefore very irregular. Malaya and Java were more fortunate. Whilst the main features of rubber preparation are the same in all three countries, differences in detail have developed and the following is an attempt to summarise them.

* The preference for artificially heated drying sheds for crepe rubber in Java is in much lesser way a consequence of an extraordinary high content of moisture in the air than of the desire to be independent of the climate and the time of day as well as to be able to manufacture a rather thickish crepe in order to obtain a higher working capacity of the milling battery. During the dry season crepe rubber in Java will be dry in air at ordinary temperature within a week's time, just the same as in Ceylon. By employing artificial heating the danger of developing mould on crepe even in exceptionally cold and rainy weather is practically nil.—(Comment by the Director of the Java Proefstation voor Rubber).

Operation	Ceylon	Malaya	Java	Comments
Tapping	Half spiral cut 4-6 ins. per annum.	Chiefly V cut 9-12 in. per annum.	Half spiral cut 9-12 ins. per annum.	Ceylon cuts are thinner and less steep than elsewhere owing to slower bark renewal caused by climatic differences.
Latex collection	Latex is collected in coconut shells hung on an ingenious type of spout. After the collection of the latex the cups are sometimes inverted on sticks or left lying on the ground.	Latex is collected in porcelain or glazed earthenware cups hung on wire loops round tree. Glass cups are sometimes used. Aluminium cups are not favoured because they quickly become hot in immature areas and during the wintering season, and the film of latex left in the cups after collection becomes tacky.	Latex is collected chiefly in aluminium cups hung on loops round trees. These are taken every day to the factory by the tappers, thoroughly cleaned and dried and inspected by the factory assistant.	The temperature in the rubber growing districts of Ceylon is lower than in the other countries and fermentation of the latex, causing bubbles in the rubber, does not occur so readily. Hence there is not the same obvious need for cleanliness. It is probable that strict attention to the cleanliness of cups in Ceylon would result in an improvement in the average inherent quality of rubber from the Island.
	*To prevent premature clotting an anticoagulant is necessary on a few estates and for this purpose sodium sulphite is used.	It is frequently necessary to employ an anticoagulant to prevent premature clotting and for this purpose sodium sulphite is used.	The addition of anticoagulants is seldom necessary. Sodium carbonate is officially recommended as a remedy against premauture clotting in the case of sheet manufacture and sodium sulphite for crepe.	The use of sodium carbonate as an anticoagulant was found to cause bubbles in Ceylon and Sumatra. Some technologists prefer ammonia as an anticogulent as it lowers the viscosity of the latex and enables dirt to settle out more easily. The possible effect of ammonia on brass in strainers resulting in the presence of copper in the rubber was discussed at the Java Conference but no definite conclusion was reached. This is a point which requires investigation.

* Sodium sulphite has the disadvantage of delaying drying and absorption of smoke. Ammonia would probably be more satisfactory, but has not been tested in Ceylon (Comment by Chemist in Ceylon—T. E. H. O'Brien).

Operation	Ceylon	Malaya	Java	Comments
Latex treatment	Rubber content of latex determined by metrolac or glass hydrometer.	Rubber content of latex determined by metrolac. Daily crop estimates are usually made by weighing the wet rubber after a definite period of dripping, making allowance for the moisture content. For the estimates of dry rubber content of preserved latex for export trial coagulations are made.	Rubber content of latex determined by trial coagulation and crepeing.	The Java Proefstation voor Rubber considers that the use of specific gravity instruments for the determination of the dry rubber content of latex is unsound. Scientific workers in Malaya do not consider latexometers as accurate as trial coagulations, but consider them sufficiently accurate for the control of standardisation of latex for coagulation purposes. The opinion in Ceylon is that the results given by glass hydrometers are as accurate as those given by trial coagulation, as carried out on estates.
	Latex strained before dilution.	Latex strained before dilution. Settling tanks are now being installed in which diluted latex is placed, in order to separate sand. Vertical sieves for straining which have been used on a few estates for years are being recommended for all estates.	On some estates elaborate sieves are built into tanks for straining before and after dilution.	Great interest was displayed at the Java Conference in a series of graded vertical sieves; which allowed the dirt to settle to the bottom of the containing vessel so that there was less likelihood of dirt penetrating through the meshes of the sieve.
	*More acetic than formic acid is used for coagulation.	More formic than acetic acid is used for coagulation.	More than 90 per cent. of the estates use formic acid for coagulation.	

* The use of formic acid is extending in Ceylon and probably now exceeds that of acetic acid. It causes difficulty in sheet manufacture on certain estates owing to rapid coagulation. (Comment by Chemist in Ceylon, T. E. H. O'Brien).

Operation	Ceylon	Malaya	Java	Comments
Crepe manufacture				
(a) bulking and dilution	Latex as received is poured into Shanghai jars and then diluted to 20 per cent. dry rubber content.	Latex as received is usually poured into Shanghai jars and diluted to 20 per cent. dry rubber content.	Latex is bulked in tiled tanks in factories visited and diluted to 20 per cent. dry rubber content.	
(b) bisulphite	Bisulphite is added to obtain pale colour.	Bisulphite is added to obtain pale colour.	Bisulphite is added to obtain pale colour.	
(c) period coagulum in serum	Coagulum is removed the day following the addition of acid.	Coagulum is removed the day following the addition of acid.	Coagulum is removed the day following the addition of acid.	
(d) machining	Coagulum machined about five times.	Coagulum machined about twelve times.	Coagulum machined about twelve times.	The coagulum in Ceylon is mostly converted into lace crepe which is blanketed when dry. In Malaya and Java the coagulum is converted into thin crepe of even texture which requires no further treatement when dry.
(e) drying	The drying room is usually over the factory, and when the weather is favourable the crepe can be dried in 5 days. In some factories the crepe is dried by heating in air at 140°F for 45-60 mins. In this case it is rolled on to drums in layers and cut into mats. Hot air drying is more expensive than drying in air at ordinary	The drying room is frequently over the packing room. Crepe takes 9 days or more to dry.	It is usual to heat drying room at night with hot water pipes; otherwise the crepe may take as long as 21 days to dry.	The "mat" method of drying employed on some estates in Ceylon should be more widely known.

Operation	Ceylon	Malaya	Java	Comments
(e) drying (*contd.*)	temperature and is being discontinued. It is found that crepe dries as quickly in air without heat in mat form as in single lengths. This method is therefore employed on a number of estates with a considerable saving in space and labour.			
(f) principal defect	Mouldy crepe due to slow drying in wet weather gives considerable trouble on some estates. On blanketing this causes a discolouration of the crepe. The remedies suggested by Mr. O'Brien were cleanliness, washing drying room with 2% formalin, and the use of paranitrophenol.	Spot disease due to slow drying or dampness.	Spot disease due to slow drying or dampness.	The defects in Ceylon are peculiar to blanket crepe and those in Malaya and Java to thin crepe.
Sheet manufacture				
(a) bulking	Latex as received is usually poured into Shanghai jars. A few estates employ bulking tanks.	Latex poured into tanks.	Latex poured into tanks.	
(b) dilution	Diluted to 15% dry rubber content.	Diluted to 15% dry rubber content.	Diluted to 15% dry rubber content.	

Operation	Ceylon	Malaya	Java	Comments
(c) coagulation	Acid added in jars or tanks and the latex transferred quicky to dishes. Sometimes latex is coagulated in shallow troughs and the coagulum handled in long lengths.	Acid added in tanks and vertical partitions inserted.	Latex transferred to dishes and acid added to each dish.	A study is being made at the Rubber Research Institute, Malaya, with regard to the most suitable depth of tank.
(d) period coagulum in serum	Coagulum machined the day after the addition of the acid.	Coagulum machined the day after the addition of the acid.	Coagulum machined the same day as the addition of the acid.	
(e) machining	Coagulum passed through a series of hand rollers on most estates.	Coagulum passed through a series of power driven rollers.	Coagulum passed through a series of power driven rollers.	One estate manager in Malaya had studied the machining of sheet very thoroughly and by increasing the depth of latex in the coagulating tanks thus producing a wider sheet, and by speeding up the machines had appreciably decreased the cost of this operation. The problem is also under investigation at the Rubber Research Institute, Malaya.
(f) soaking and dripping	Wet sheets allowed to drip in shade for about an hour.	Wet sheets allowed to drip in shade for about an hour.	Sheets soaked overnight in water and then allowed to drip.	The soaking process in Java is stated to prevent the development of mould.

Operation	Ceylon	Malaya	Java	Comments
(g) smoking	Sheets smoked to a fairly dark colour. Many types of smoke-house.	Sheets smoked to a light colour. Elaborate smoke-houses.	Sheets smoked to a dark colour. Cheap smoke-houses which are probably efficient.	Professor de Vries expressed the opinion that it was unwise to encourage the market to demand a light coloured smoked sheet which might become mouldy very easily. The Rubber Research Institute, Malaya, is continually advocating the preparation of a darker smoked sheet. Considerable interest in the construction and dimensions of smoke-houses is being taken in Ceylon and Java and improvements are to be expected in the next few years.
(h) mould prevention	Paranitrophenol is used on a number of estates. Sometimes the sheets are soaked in it and sometimes it is added along with the coagulant.	Paranitrophenol was used extensively during the restriction period, but owing to additional cost its use has decreased considerably now that rubber is again placed on the market shortly after preparation.	Paranitrophenol is not required.	Machining on the day of coagulation, followed by soaking and heavy smoking in Java, tends to produce a sheet which vulcanises as slowly as crepe in a rubber-sulphur mixing.
(i) packing	Lining sheets used in packing. The rubber is not usually pressed into cases on account of complaints of massing. The cases therefore contain somewhat less than 220 lb. of rubber (170-180 lb.). 224 lb. per case is recommended by the Rubber Research Scheme.	Lining sheets are used in packing of the same grade as the contents. The rubber is usually pressed into cases which hold 224 lb., so that ten cases contain exactly one ton of rubber. In the case of thin crepe about 175 lb. are pressed into each case.	Lining sheets used in packing. The rubber is pressed into cases which hold about 220 lb.	An estate in Malaya supplying direct to the manufacturer baled all its rubber. The massing of rubber is of no importance unless the rubber has to be resorted at the docks or used by manufacturers without adequate machinery.

GENERAL COMMENTS ON METHODS OF PREPARATION

A. *Preparation of intrinsically uniform rubber.*—Owing to local modifications in the method of preparation it is to be expected that there will be general differences in the vulcanising properties of rubber from Java, Malaya and Ceylon. The most striking is likely to occur in the case of smoked sheet which, owing to machining soon after coagulation, soaking in water overnight, and heavy smoking, probably vulcanises more slowly when obtained from Java than when obtained from Ceylon or Malaya.

On the whole it is considered that methods of preparation do not differ greatly on estates in the same country and that the important source of variability is due to the varying characteristics of individual trees (see de Vries, Estate Rubber, p. 50). As long as rubber is the product of life processess in a tree it will not be possible to obtain strictly uniform material without submitting it to drastic chemical purification. Nevertheless it is possible to prepare much more uniform material than at present. For this purpose bulking on a large scale should be encouraged and when the standard method of preparation is found to yield a material with abnormal vulcanising and mechanical properties the method of preparation should be modified (Cf. Programme of Work, January 1st, 1930). This is the practice in connection with the preparation of "Certificate Rubber" in Java. Professor de Vries considers that the demand for this type of rubber is disappointing. On the other hand it is possible that the rubber is not as uniform in manufacturing operations and service as the laboratory tests indicate (Cf. Dinsmore and Zimmerman, Ind., Eng., Chem., 18, 1926, p. 144). It is important that the results of laboratory tests should bear a relation to results obtained in commercial practice, and this is a subject to which a considerable amount of attention has been given by the London Staff of the Rubber Research Scheme. The information obtained is of practical value in connection with the attempts now being made to encourage the preparation of uniform rubber throughout Ceylon.

As the area under budded rubber increases variations in the properties of rubber will probably decrease, particularly if care is taken to ensure that no tree is used as a source of budwood which yields rubber with abnormal properties when prepared by a standard method. This question is under consideration in London and has been studied elsewhere (*India Rubber Journal*, November 16, 1929, p. 159).

When the rubber tree population becomes less mixed it may be possible to prepare uniform rubber throughout Ceylon by a careful standardisation of the processes of preparation, but at present local modifications are necessary.

Acting Director, Rubber Research Institute, Malaya.

Comment by B. J. Eaton.—"In Malaya, I consider the lack of uniformity is due mostly to differences in methods of preparation on different estates. The considerable bulking of all the latex on any one estate eliminates differences due to varying characteristics of individual trees. The fact that the rates of vulcanisation of smoked sheet and thin pale crepe in Java are very similar, is probably due to the machining on the day of coagulation and the soaking overnight in water, whereas the coagulum for crepe manufacture is machined on the day after coagulation.

"The more rapid rate of vulcanisation of sheet compared with thin pale crepe in Malaya is due to the fact that generally the coagulum for both sheet and crepe is machined on the day after coagulation."

Author's Comment.—The views expressed in this report are partly based on results obtained with crepe and sheet from latex from different estates in Ceylon using the same method of preparation. The question is receiving attention in connection with the survey of the intrinsic quality of Ceylon rubber now being made.

B. *Dirt.*—Very few estates realise how important it is to keep out of the latex fine particles of dirt which are too small to be removed by straining. The use of *sheraties* (coconut shells), which is the general practice in Ceylon, is a doubtful economy and may be more instrumental in limiting the use of rubber than is generally realised.

Comment by B. J. Eaton.—"During this year much attention has been paid to this problem and large scale experiments have been carried out by the Chemical Division of the Rubber Research Institute of Malaya on estates. A vast improvement has been effected by (a) use of settling tanks in which diluted latex is allowed to stand for about 10-15 minutes before straining and transfer to coagulation tanks, and (b) by the advocation and use of vertical strainers."

Village Sheet.—An interest was taken in the preparation of smoked sheet rubber on small holdings in Ceylon. As the latex from which the individual sheets are prepared is obtained from a small group of trees, the rubber must be variable, but it is probably averaged by the various brokers who handle it. Nevertheless it is expected that batches of 100 lb. will vary more than the corresponding amounts from large estates. The method of sun drying is open to criticism as it may cause deterioration of the rubber.

Comment by B. J. Eaton.—"In Malaya co-operative factories and smokehouses are being started to improve and render such rubber more uniform. It is also anticipated that a higher market price equivalent to that obtained by large European managed estates will result."

For the information contained in this report the author acknowledges his indebtedness to Professor de Vries and Dr. Riebl in Java, Major B. J. Eaton in Malaya and Mr. O'Brien in Ceylon who all devoted a considerable amount of time to enable him to obtain the maximum advantage of his tour in the East. He also appreciates their kindness in correcting and commenting on this report.

NOTICES.

SUBSCRIPTIONS.

Arrangements have now been made for Bulletins and Circulars of the Ceylon Rubber Research Scheme to be made available to non-contributors to the Scheme at the rate of Rs. 15-00 per annum, post free.

GLASS HYDROMETERS.

Glass hydrometers for testing latex and for testing formic acid as specified and as recommended by the Rubber Research Scheme (Ceylon) may be obtained at a cost of Rs. 12·50 and Rs. 10·50 each respectively, from :—

Messrs. WALKER, SONS & CO., Ltd.,
Engineering & Estate Supplies Department,
Colombo.